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MECHANICAL POWER TRANSFER SYSTEMS. AGRICULTURAL MACHINERY-SERVICE OCCUPATIONS, MODULE NUMBER 8.
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ONE OF A SERIES DESIGNED TO HELP TEACHERS PREPARE POSTSECONDARY-LEVEL STUDENTS FOR THE AGRICULTURAL MACHINERY SERVICE OCCUPATIONS AS PARTS MEN, MECHANICS, MECHANIC'S HELPERS, AND SERVICE SUPERVISORS, THIS GUIDE AIMS TO DEVELOP STUDENT COMPETENCY IN UNDERSTANDING AND APPLYING THE PRINCIPLES OF MECHANICAL POWER TRANSMISSION IN AGRICULTURAL MACHINERY. IT WAS DEVELOPED BY A NATIONAL TASK FORCE ON THE BASIS OF RESEARCH FROM STATE STUDIES. SUGGESTIONS FOR INTRODUCING THE MODULE ARE GIVEN. UNIT AREAS INCLUDE--(1) CLUTCHES, (2) TRANSMISSIONS, (3) DIFFERENTIALS AND FINAL DRIVES, (4) STEERING AND BRAKES, (5) PULLEYS AND BELTS, (6) SPROCKETS AND CHAINS, (7) GEARS, AND (8) BEARINGS. EACH UNIT INCLUDES SUGGESTED SUBJECT-MATTER CONTENT, TEACHING-LEARNING ACTIVITIES, INSTRUCTIONAL MATERIALS, AND REFERENCES. SUGGESTIONS FOR EVALUATING EDUCATIONAL OUTCOMES ARE INCLUDED. SUGGESTED TIME ALLOTMENT IS 24 HOURS OF CLASS INSTRUCTION AND 36 HOURS OF LABORATORY EXPERIENCE. TEACHERS SHOULD HAVE EXPERIENCE WITH AGRICULTURAL MACHINERY. STUDENTS SHOULD HAVE MECHANICAL APTITUDE AND AN OCCUPATIONAL GOAL IN AGRICULTURAL MACHINERY. THIS DOCUMENT IS ALSO AVAILABLE FOR A LIMITED PERIOD AS PART OF A SET (VT 000 488 THROUGH VT 000 504) FROM THE CENTER FOR VOCATIONAL AND TECHNICAL EDUCATION, THE OHIO STATE UNIVERSITY, 980 KINNEAR ROAD, COLUMBUS, OHIO 43212, FOR $7.50 PER SET. (JM)

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MECHANICAL POWER TRANSFER SYSTEMS

One of Sixteen Modules in the Course Preparing for Entry in

AGRICULTURAL MACHINERY - SERVICE OCCUPATIONS

Module No. 8

The Center for Research and Leadership Development

in Vocational and Technical Education

The Ohio State University
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Columbus, Ohio, 43212

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M E M~~O R A~~ N D U M

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RE: (Author, Title, Publisher, Date) Module No. 8, "Mechanical Power Transfer Systems," The Center for Vocational and Technical Education, August, 1965.

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Student Selection Criteria Post high school, mechanical aptitude, high school background, goal in agricultural machinery service occupation.
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MECHANICAL POWER TRANSFER SYSTEMS

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MECHANICAL POWER TRANSFER SYSTEMS

Major Teaching Objective

To understand and apply the fundamentals and principles of mechanical systems of power transmission in agricultural machinery

Suggested Time Allotments

At school		
Class instruction	24	hours
Laboratory experience	36	hours
Total at school	60	hours
Occupational experience	0	hours
Total for module	60	hours

Suggestions for Introducing the Module

The whole spectrum of career opportunities in agricultural machinery occupations involves, to a certain extent, a knowledge of the fundamentals and principles of power transmission. Whether tractors or engines are used as stationary or portable power plants to drive or pull various types of equipment, the power delivered by the engine must be transmitted through some type of transmission system to the equipment performing the job. The power train of a tractor which transmits the power from the tractor engine to the wheels involves two or more methods.

Although hydraulic systems of transmitting power are used extensively on tractors and other farm equipment, mechanical systems remain the basic method of transmitting power from its source to its use.

The complexity of the construction of agricultural equipment makes it essential that a person desiring employment in this area have a knowledge and understanding of the fundamentals and principles involved in mechanical power transmission.

The following technique should be used to create interest in the module:

> Bring before the class an item of equipment which operates through pulleys and belts from a stationary engine. Remove the pulleys and belts, start the engine, and ask students to explain why the item of equipment is not operating. Also bring a tractor and another item of equipment with a mounted engine before the class. Have the students examine each item of equipment and list the points or places through which power

is transmitted from the source to the use. Have a general discussion in which class members give their interpretation of how power is transmitted from its source to its use.

Competencies to be Developed

I. To (1) understand the function of the clutch and to (2) identify its parts

Teacher Preparation

Subject Matter Content

The purpose of the clutch is to connect or disconnect a machine from the source of power, or, as is the case with a tractor, to connect or disconnect the engine to or from its load.

There are two basic types of clutches used on agricultural machines.

1. Friction
2. Positive

The friction clutch is used on tractors and machines with their own source of power, such as the self-propelled combine.

On tractors, clutches are of two types.

1. Dry
2. Wet

The dry-type clutch is equipped with a driving plate and a driven plate. The driving plate is lined with friction surfaces that are pressed against the driven plates when the clutch is engaged. These friction surfaces which are extremely smooth, increase the frictional surface of the plate.

The multiple-disc clutch, commonly used in crawler tractors, has many driving and driven discs and runs in oil. This type of clutch is called a wet-type clutch.

The two kinds of clutches most commonly used on the majority of row crop tractors today are:

1. Spring-loaded foot-operated clutch
2. Over-center hand-operated clutch

On the spring-loaded foot-operated clutch, spring pressure clamps the driven disc between the pressure plate and the flywheel. The foot pedal is used to disengage the clutch. The spring-loaded foot-operated clutch is composed of the following main parts:

1. Driven disc
2. Pressure plate
3. Pressure spring
4. Shift rod
5. Throw-out bearing

The over-center hand-operated clutch is operated by a hand lever and cam mechanism. The driving plate is attached to the flywheel. Drive plates drive the power shaft that supplies power to the transmission. When the driving clutch is engaged, the driven plate is forced against the driving plate by the yoke assembly. The over-center hand-operated clutch is comprised of the following main parts:

1. Driven plates
2. Driving plates
3. Yoke assembly for engaging the clutch
4. Clutch shift
5. Thrust plate
6. Clutch brake

The safety snap clutch is a friction-type clutch used on agricultural machinery. Two notched plates are pressed together by springs of sufficient force to permit power to be transmitted for normal predetermined working loads. In the event that an overload occurs on the clutch, it slips with a snapping action and prevents damage to the working unit. This type of clutch is commonly used on corn pickers, forage harvesters, and haying machines.

The positive clutch consists of two parts. Each part has jaws so shaped and placed as to lock together as a unit when they are engaged. They are used on machines transmitting light loads at slow speeds, such as planters and grain drills.

In the main, three types of positive-type clutches are used on agricultural machinery.

1. Ratchet-and-pawl

2. Overriding or overruning

3. Belt tension
(See Farm Machinery and Equipment, pp. 42-44, for discussion of each of the above.)

Suggested Teaching-Learning Activities

1. Bring before the class a clutch of each type identified in the content and demonstrate how each one works.

2. Tour an agricultural machinery dealership to observe the use of clutches on agricultural machines.

3. Have students disassemble each type of clutch discussed in the content, learn its parts, and reassemble them.

4. Demonstrate the proper use of tools used in disassembling clutches.

Suggested Instructional Materials and References

Instructional materials

1. Clutches of the types identified in the content

2. Tools used in disassembling clutches

References

1. Farm Machinery and Equipment, pp. 41-44.

2. Modern Farm Power, pp. 160-164.

3. Machines for Power Farming, pp. 96-100.

4. Manufacturer's service manuals.

II. To (1) understand the function of the transmission and to (2) identify its parts

Teacher Preparation

Subject Matter Content

The transmission is the speed-reducing mechanism on the tractor. It provides a mechanical means of

1. Transmitting power to the driven member of the machine
2. Increasing and decreasing speed or power of the machine
3. Controlling travel (forward or backward) of the machine

Speed reduction is accomplished through sliding (speed-changing) gears. The simple transmission is composed of the following parts:

1. Drive shaft
2. Gears
3. Transmission countershaft
4. Main shaft

The gears on the end of the drive shaft and the countershaft are in constant mesh. The gears located on the main shaft are moved into position with the gears on the countershaft to obtain the desired speed of travel. Figure 7-4 on page 101 of Machines for Power Farming illustrates the function of the transmission parts and the flow of power through the transmission. The gears on the main shaft are movable. By shifting these gears forward or backward on the main shaft, the flow of power and the speed at which the machine is operating can be changed.

Transmissions in tractors are designed for power. The only time speed is needed is when the tractor is operated in road gear. The gear ratio in a transmission is low in relation to speed, and high in relation to torque.

Tractors require different gear ratios to meet varying operating requirements. The two ways of referring to a

change from one gear ratio to another in a simple gear train are constant-mesh and sliding gear shifting.

Reverse speed is obtained by engaging the small pinion gear between the countershaft and the sliding gears.

Several types of transmissions are used in tractors.

1. Single shift

2. Dual shift

   These types of transmissions include only gear transmissions in which one gear must mesh and slide into another in order to shift from one gear to another.

3. Shift-on-the-go

   This type of transmission includes planetary gears. Gears are in constant mesh and are applied or released by a hydraulic clutch. Transmissions included in this type are

   a. Select-O-Speed

   b. Case-O-Matic

   c. Torque amplifier

   d. Power director

   e. Synchro-range

   f. Multi-power

   g. Hydra-power

      These transmissions can be shifted from one speed to another while the tractor is in operation.

<u>Suggested Teaching-Learning Activities</u>

1. Using wall charts, teacher-made transparencies, and the reference illustrations, discuss the operation and parts of the various types of transmissions.

2. Demonstrate the operation of a simple transmission. Use a cutaway of an actual transmission for demonstrating this operation.

3. Demonstrate proper usage of transmission disassembly and repair tools.

4. Have students disassemble a simple transmission, learn its parts and their functions, and reassemble the parts.

5. Tour several agricultural machinery dealerships to study the types of transmission used on the tractors in each dealership.

Suggested Instructional Materials and References

Instructional materials

1. Charts, overhead transparencies, and cutaway models of transmissions

2. A simple transmission for each student

References

1. Transmission Theory.

2. Modern Farm Power, pp. 164-170.

3. Machines for Power Farming, pp. 100-104.

III. To (1) understand the functions of the differential and final drive and to (2) identify their parts

Teacher Preparation

Subject Matter Content

The purpose of the differential is to divide the power transmitted to the two rear wheels. This power should be divided equally when the tractor moves straight forward and unequally when the tractor turns.

The differential is made up of the following parts:

1. Transmission spline shaft

2. Bevel pinion gear on transmission shaft

3. Differential bevel pinion gears (spider gears)

4. Slide gears

5. Ring gear

6. Countershaft

The ring gear is driven by the bevel pinion on the transmission spline shaft. The differential bevel pinions are located on the sides of the ring gear and are mounted on the axle stubs. The spider and bevel pinion assembly makes the only connection between the ring gear and the two bevel side gears, which are keyed to the inner ends of the final drive countershafts. Both these bevel side gears are in constant mesh with the four differential pinions.

The entire differential assembly revolves when the tractor moves straight ahead. When one rear wheel meets additional resistance, for example, in turning, the differential pinions not only are carried around by the housing but also begin to rotate on their stub axles. The differential pinions then ride on one of the bevel gears and drive the others, thus driving one wheel faster than the other.

The purpose of the final drive is to reduce greatly the speed of the engine before it is applied to the drive wheels.

The final drive is made up of the following parts:

1. Pinion gear

2. Bull gear

3. Side gears

4. Axles

5. Shafts

6. Housing

The belt pulley on some tractors is placed at the rear of the tractor and is driven by the PTO shaft. It is usually placed on the right side near the center of the tractor.

The power flows through a set of bevel gears sitting at a right angle with the engine crankshaft to the pulley. It is driven by a bevel gear located on the transmission driving

shaft. A special clutch, or throw-out, permits the belt pulley to be kept out of operation.

Several types of PTO's are found on tractors.

1. Constant-running. With this type, the PTO will continue to run after the forward motion of the tractor is stopped.

2. Independent. With this type, the PTO can be stopped without having to stop the tractor.

Power from the engine is transferred to the machine through telescoping shafts and universal joints.

Suggested Teaching-Learning Activities

1. Using charts and projected diagrams, discuss with the class how the differential, final drive, belt pulley, and PTO on a tractor operate.

2. Using cutaways of actual models, demonstrate these tractor parts to the class.

3. Demonstrate proper usage of tools to repair these tractor parts.

4. Have the students disassemble these tractor units, study their parts, and reassemble them.

5. Tour agricultural machinery dealerships to observe the variations in application of these tractor units.

Suggested Instructional Materials and References

Instructional materials

1. Charts, cutaways, and enlarged views of the differential, final drive, belt pulley, and PTO of a tractor

2. A differential, belt pulley, and PTO for each member of the class

References

1. Machines for Power Training, pp. 104-109.

2. Modern Farm Power, pp. 170-173.

3. Manufacturer's service manuals

IV. To (1) understand the functions of the steering mechanism and brakes on tractors and to (2) identify their parts

Teacher Preparation

Subject Matter Content

The purpose of the steering mechanism on a tractor or self-propelled agricultural machine is to change the direction of the machine while it is in motion.

Two types of steering mechanisms are commonly used on wheel tractors.

1. Worm-and-lever
2. Worm-and-sector

On each type of steering mechanism, the sector or lever rides in the grooves of the worm gear, which is located on the steering shaft opposite the steering wheel. When the steering wheel turns, the lever or sector riding on the worm gear moves up or down. This movement, in turn, moves the pitman arm that is connected to the shaft running to the front wheel steering assembly and turns the wheels in the desired direction. (See Modern Farm Power, p. 191, for illustrations of the above types of steering mechanisms.)

In recent years, hydraulic principles have been applied to steering mechanisms to make machine steering easier. On most tractors, vane-type hydraulic power steering units are used. A positive displacement pump supplies the hydraulic oil to the power steering unit, and a value arrangement directs the flow of oil to both sides of the steering cylinder.

Crawler tractors are steered by either a clutch-and-brake arrangement or a brake-and-differential-drive arrangement. (See Modern Farm Power, pp. 194-195, for illustrations of the above-mentioned crawler steering mechanisms.)

Brakes on a tractor serve several purposes: For turning and stopping the vehicle and for providing the tractor operator with a means of safely operating his tractor.

Three types of brakes are in common use on tractors.

1. Disk
2. External-band
3. Internal-expanding shoe

The disk type of brake is found either on the rear axle shaft or the differential shaft. Applying the brake causes the friction plate to be clamped between stationary plates. The friction plates are attached to the axle shaft or differential. When the stationary plate clamp is against the friction plate, the axle is stopped or slowed down. The disk-type brake is illustrated in Modern Power Farming on page 195.

The drum of the external-band type of brake is attached to the axle shaft or differential shaft and rotates with the axle. A band with a friction surface lining fits around the outside of the drum. When pressure is applied against the foot pedal of the brake, the linkage between the foot pedal and the bands tightens and clamps the external band against the drum, causing the tractor to slow down or stop. The external-band type of brake is illustrated on page 196 of Modern Power Farming.

The internal-expanding brake is located on either the axle or the differential shaft. It consists of a set of stationary brake shoes and a set of drums. When the brake is applied, the shoes are forced against the drums, causing the tractor to stop or slow down. See page 197 of Modern Power Farming for an illustration of the internal-expanding brake.

Suggested Teaching-Learning Activities

1. Using cutaways and mockups, demonstrate before the class how each type of steering mechanism and brake operates.

2. Have students disassemble each type of steering mechanism and brake, learn its parts, and reassemble them.

3. Identify and demonstrate special tools used in disassembling steering mechanisms and brakes.

Suggested Instructional Materials and References

Instructional materials

1. Cutaways and mockups of the steering mechanisms and brakes discussed in the content

2. Tools used in disassembling steering mechanisms and brakes

References

Modern Farm Power, pp. 190-196

V. To understand pulleys and belts as a means of power transmission

Teacher Preparation

Subject Matter Content

Because of their adaptability, belt pulleys and belts are used on many machines as a means of transmitting power. Power can be transmitted from less than a few feet to 100 feet or more. This system is used extensively on machines such as feed grinders, silage blowers, corn shellers, and irrigation pumps. Often tractors equipped with belt pulleys are used as stationary power units for belt-driven equipment.

There are two types of belts and pulleys.

1. V-belt
2. Flat belt

V-belts have gained in popularity during recent years. Advantages of a V-belt includes

1. It is simple and compact.
2. There is good pulley contact and very little slippage if the belt is given correct tension.
3. It cannot slip off pulleys.
4. Speeds can be changed without changing the entire pulley.

The flat belt pulley is usually "crowned"; that is, the diameter at the center of the pulley is a littler greater than at the outer edges. The crown helps keep the belt aligned when the pulley is moving.

Belting materials are usually leather, canvas, or rubber. Leather is an excellent material but is expensive and must be kept dry. Canvas belting is durable and withstands exposure to moisture and oil, but stretches or shrinks under certain conditions. Rubber belting is used extensively on farm equipment but does not withstand oils and greases.

Pulleys may be constructed of a number of materials. Most, however, are made of wood, steel, cast iron, fiber, or paper.

Correct size and speed of pulleys is very important. Persons planning for employment in an agricultural machinery occupation must have an understanding of the basic laws of physics and mathematics relative to pulleys and belts and be able to apply this understanding to practical situations.

The following equation should be used in determining pulley sizes and speed:

Equation 1 (To determine the size of pulley needed to give a machine the proper speed)

D = diameter of driver
S = speed of driver
d = diameter of driven pulley
s = speed of driven pulley

$D \times S = d \times s$

Example:

A 12-inch driver pulley on an agricultural machine that turns 800 r.p.m. is to operate a driven pulley at 2400 r.p.m. What size should the driven pulley be to operate at 2400 r.p.m.?

$$12 \times 800 = d \times 2400$$
$$d = \frac{12 \times 800}{2400} = 4 \text{ inches}$$

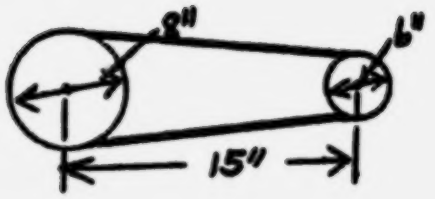
Often pulley belts wear or break on agricultural machines with pulleys of unequal sizes and must be replaced. The problem then is to determine the size of pulley with which to replace the worn or broken belt. The following methods should be used to determine the size of belt to use.

V-belt

The following formula should be used to determine the length of a V-belt.

$$L = 2C + 1.57 (D+d) + \frac{(D-d)}{4C}$$

L = length of belt
C = distance between centers of sheaves
D = outside diameter of large sheaves
d = outside diameter of small sheaves



$$L = (2 \times 15) + 1.57\ (8" + 6") + \frac{(8" - 6")}{(4 \times 15)}$$

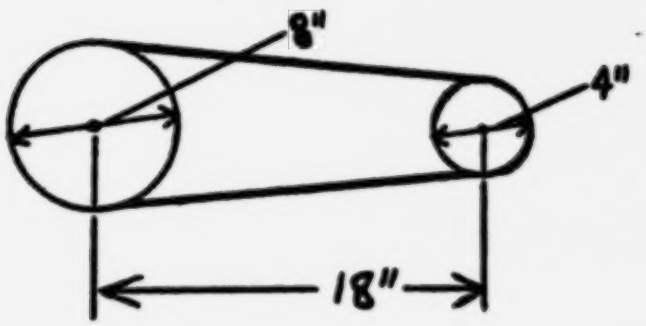
$L = 30 + 21.98 + .03$
$L = 52.01"$ or $52"$

Flat belts

The following method should be used to determine the size of flat belt needed.

1. Add together the diameters of the two pulleys.
2. Divide this sum by 2 and multiply the quotient by 3.
3. To this product, add twice the distance between the centers of the two pulley shafts.

Example:



1. $8" + 4" = 12"$
2. $2 \div 12" \times 3" = 18"$
3. $18" + 18" + 18" = 54"$

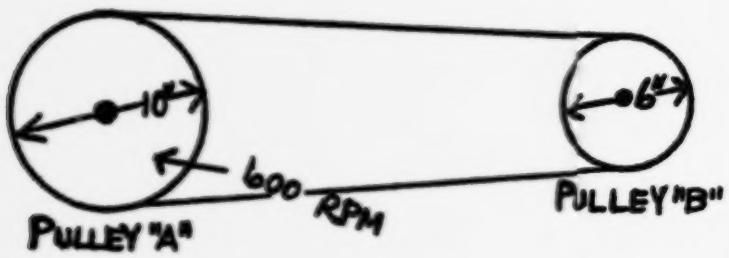
Suggested Teaching-Learning Activities

1. Have students examine several pieces of equipment which use flat and V-belts.

2. Have students cut used flat and V-belts to study their construction.

3. Have students work the following problems. Emphasize the purpose involved in each problem.

   a. To step up the speed of a pulley, using a large pulley to drive a small pulley.



   Pulley "a" is the driver pulley. How fast will pulley "b" turn?

   b. A 10" pulley running on the PTO shaft of a tractor is turning 540 r.p.m. The driven pulley on the machine is supposed to turn 1000 r.p.m. How large a driven pulley should be used to obtain a speed of 1000 r.p.m.?

   c. To slow down the speed of a pulley, using a small pulley to run a large pulley. A 4" driven pulley is turning 1000 r.p.m. The driven pulley on the machine is supposed to turn 600 r.p.m.'s. How large a driven pulley should be used to obtain a speed of 600 r.p.m.? Assume that the pulley shafts are 15" apart, and determine the length of V-belt and flat belt needed to drive the driven pulley.

Suggested Instructional Materials and References

Instructional materials

1. Samples of belt materials

2. Several V-belt and flat belt pulleys of various sizes which can be mounted on axles

3. Belts of various lengths

4. Diagrams of various kinds of pulleys and belts

5. One or more pieces of agricultural equipment for student use

References

1. Modern Farm Power, pp. 182-187.

2. Farm Machinery and Equipment, pp. 26-31.

3. Farm Gas Engines and Tractors, pp. 404-445, 475-479.

Suggested Occupational Experiences

Have students determine size and install pulleys on agricultural machines at the agricultural machinery dealership.

VI. To understand sprocket wheels and chains as a means of power transmission

Teacher Preparation

Subject Matter Content

Sprocket wheels and chains are positive means of power transmission. They are satisfactory even when the driving and the driven parts of the machine are several feet apart or when considerable speed reduction is desired.

Advantages of the sprocket and chain method of power transmission include:

1. Because it is positive, there is no slippage.

2. It can be coupled and uncoupled easily.

3. Chains absorb shock.

4. A small variation in the distance between sprocket centers is not harmful.

Types of chains include:

1. Detachable-link or hook-link chain

2. Pintle chain

3. Roller chain

4. Silent chain or chain belt

The detachable-link or hook-link and the roller are the two types of chains commonly used on agricultural equipment.

The roller-link chain is used for light work and medium speeds.

The pintle chain is used for heavy-duty and slow-speed work.

The roller chain, used for heavy-duty work, is also used extensively in the final drives of tractors, trucks, and self-propelled machinery.

The silent chain is a special type of chain, with the characteristics of a flexible metal corrugated belt. It is used for high-speed light work in engines, such as driving the cam shaft.

Suggested Teaching-Learning Activities

1. Have students examine various types of chains and sprockets.

2. Have students determine sizes of sprockets needed on a piece of equipment, according to varying requirements and uses of the machine.

3. Have students replace sprocket wheels and repair chains on agricultural machines.

Suggested Instructional Materials and References

Instructional materials

1. Several sizes of sprockets

2. Several lengths of chains for students to use with the various sizes of sprockets.

3. Samples of each type chain

4. One or more pieces of agricultural equipment for student use

5. Pictures and diagrams of chains and sprockets and their uses

References

1. Farm Machinery and Equipment, pp. 31-34.
2. Farm Gas Engines and Tractors, pp. 482-483.

VII. To understand gears and gearing as a means of power transmission

Teacher Preparation

Subject Matter Content

Gears, like sprockets and chains, are a positive means of power transmission. Positive power transmission means there is no slippage, as often occurs with pulleys and belts.

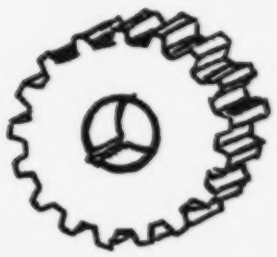
Gears and gearing are restricted primarily to the transmission of power from one part of a machine to another part of the same machine. Gears are also used extensively as a means of reducing or increasing speed of various parts of a machine.

Gears and gearing often are a more expensive means of power transmission than sprockets and chains, since the complete system may need to be replaced when repairs are needed.

Gears may be classed according to the following types:

1. Spur gear

   The shafts of spur gears are parallel, and their teeth are arranged so that their axes of rotation are parallel to the axes of rotation of the gears with which they mesh.



SPUR GEAR

2. Beveled gear

The teeth of beveled gears are arranged so that the shafts of the two gears meshed are at right angles, or nearly so. Beveled gears are used where power must be transmitted around corners. They are used extensively for differential pinion and axle gears in tractors.

BEVEL SPUR GEAR

3. Worm gear

Worm gears consist of two parts, the worm and the sector.

An advantage of the worm gear is that it permits a large speed variation between the driving and driven members of the machine. Disadvantages include:

a. Usually it will not operate in a reverse manner.

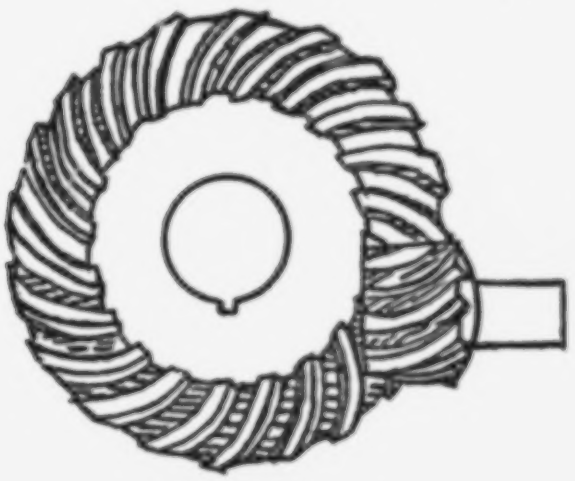
b. Its efficiency is lower than that of other types of gears.

c. Continuous lubrication is necessary during operation.

WORM GEAR

4. Hypoid gear

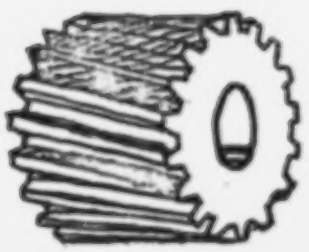
Hypoid gears are similar to spiral bevel gears except that the teeth have a distinct curvature. There is greater contact between the teeth and they operate under extreme pressure. Teeth contact is below the center line of the ring gear in tractors.



HYPOID GEAR

5. Helical gears

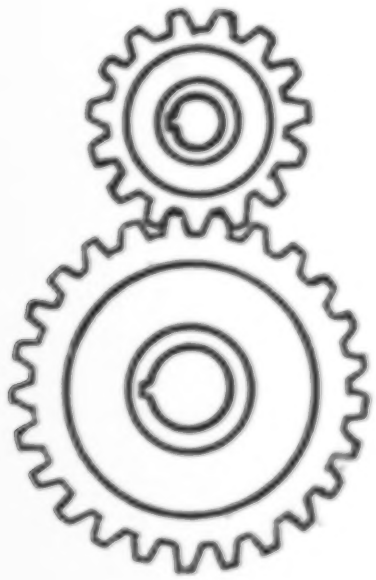
The teeth of helical gears are curved so as to remain in mesh or in constant contact longer than straight teeth. They may be of the spur gear type or the beveled gear type.



HELICAL GEAR

Agricultural machines require different gear ratios to meet varying operational requirements as demonstrated by the involvement of a transmission in the power train of a tractor. It is the function of the transmission to vary the speed, either up or down, at which the tractor is to operate. The

speed changes are made by bringing into contact gears of different sizes to transmit the power coming into the transmission. A large driving gear drives a smaller gear to increase the speed or amount of power. To reduce the amount of speed or power, a small gear drives a large gear. The relationship of gear sizes to each other is known as the gear ratio and is measured by measuring the circumferences of the two gears. An easy way to determine gear ratio is shown below.



There are 15 teeth on the small gear and 25 teeth on the large gear. The gear ratio is 5 to 3.

Suggested Teaching-Learning Activities

1. Have students study each type of gear listed in the content and be able to identify each gear upon sight.

2. Using agricultural machines, show students where each type of gear is used and demonstrate how it works in motion.

3. Using a tractor transmission, have the students determine the gear ratio when the tractor is engaged at each speed. After the students have determined the gear ratios, operate the tractor, noting the differences in speed caused by each gear ratio.

Suggested Instructional Materials and References

Instructional materials

1. Examples of each type of gear listed in the content
2. Pictures and diagrams of gears and gearing
3. Several pieces of equipment for students to disassemble or examine, including power train of a tractor
4. Tractor with transmission exposed to study gear ratios

References

1. Farm Machinery and Equipment, pp. 34, 35.
2. Farm Gas Engines, pp. 480, 481.

VIII. To understand the relationship of bearings to power transmission in agricultural machinery

Teacher Preparation

Subject Matter Content

Bearings are used in farm machinery to hold in position the various power transmitting parts and are designed to reduce the amount of resistance between these parts as much as possible.

Two types of bearings are used in agricultural machines.

1. Friction
2. Anti-friction

In friction bearings, the turning part is supported by and in direct contact with the inside surface of the bearing. The insert in the connecting rod coupling is an example of a friction-type bearing. Friction bearings are usually made of cast iron, bronze, or babbitt.

In anti-friction bearings, balls and rollers are placed between the moving part and the bearing. The rollers or balls turn with the moving part, reducing friction and wear on the moving part.

Several types of anti-friction bearings are used on agricultural machinery.

1. Ball
2. Roller

Ball bearings are more versatile than other types of rolling bearings. They operate with less friction, and may be used at higher speeds. In the diagrams on page 4 of Ball and Roller Bearings, the construction of a ball bearing is illustrated.

Several types of ball bearings are used on agricultural machinery.

1. Internal self aligning
2. Single row drop groove
3. Loading groove
4. Single row angular contact
5. Double row deep groove
6. Double row angular contact
7. Ball thrust
8. Sealed, prelubricated
   (See Ball and Roller Bearings, pp. 5-7, for a discussion of each of the above.)

Roller bearings use small cylindrical rollers that reduce friction. Roller bearings are particularly useful where the bearing is subjected to high pressure because of its larger bearing surface.

As is the case with ball bearings, several types of roller bearings are used on agricultural machinery.

1. Spherical
2. Straight
3. Spherical thrust
4. Tapered

5. Needle

6. Thrust
(See Ball and Roller Bearings, pp. 7 and 8, for examples and a discussion on each of the above listed bearings.)

Proper removal and installation of ball and roller bearings is of utmost importance if the bearing is to function properly and if damage to the moving part to which it is attached is to be avoided. Procedures for removing and installing bearings are illustrated in Ball and Roller Bearings, pp. 11-14, and 18-21.

Suggested Teaching-Learning Activities

1. Using overhead transparencies made from the diagrams Ball and Roller Bearings, discuss the various types of roller and ball bearings.

2. Show students where each type of bearing covered in the subject matter content is used on agricultural machinery.

3. Have students disassemble each type of bearing covered in the content and study its construction.

4. Demonstrate the use of bearing removal and installation tools and have each student use these tools in removing and installing bearings.

Suggested Instructional Materials and References

Instructional materials

1. Overhead transparencies of bearing types covered in the content

2. Bearings of each type identified in the content for students to disassemble

3. Bearing removal and installation equipment

References

1. Ball and Roller Bearings, pp. 1-27.

2. Shop Manual for Timkin Roller Bearings, pp. 1-81.

3. Farm Machinery and Equipment, pp. 46-49.

4. Quite Naturally (16mm film)

Suggestions for Evaluating Educational Outcomes of the Module

The following criteria should be used to evaluate the educational outcomes of this module:

1. Student interest in the material covered in this module
2. Student participation in class activities
3. The ability of the student to carry out the teaching-learning activities
4. The ability of the student to use the special tools identified in the teaching-learning activities

Sources of Suggested Instructional Materials and References

Instructional materials

1. Ball Bearing Maintenance. Bristol, Connecticut: New Departure, Division of General Motors.
2. Quite Naturally, (16mm film). Canton 6, Ohio: The Timken Roller Bearing Company.

References

1. Ball and Roller Bearings. Chicago: International Harvester Company, 180 North Michigan Avenue, 1964. Price: $1.00.
2. Basic Ball Bearing Types. Bristol, Connecticut: New Departure, Division of General Motors Corporation.
3. Bearing Failure Identification. Bristol, Connecticut: New Departure, Division of General Motors Corporation.
4. Frazee, Irving, and Eshelman, Phillip V. Tractors and Crawlers. Chicago: American Technical Society, 1957.
5. Jones, Fred R. Farm Gas Engines and Tractors. New York: McGraw-Hill Book Company, 1963.
6. New Departure Ball Bearings for Farm Implements. Bristol, Connecticut: Division of General Motors Corporation.
7. Promersberger, William J., and Bishop, Frank E. Modern Farm Power. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1962.

8. Seals, Separators, Lubricants. Bristol, Connecticut: New Departure, Division of General Motors Corporation.

9. Service Procedure for Ball Bearings. Bristol, Connecticut: New Departure, Division of General Motors Corporation.

10. Shop Manual for Timken Roller Bearings. Canton 6, Ohio: Timken Roller Bearing Company, 1952.

11. Smith, Harris, and Pearson. Farm Machinery and Equipment. New York: McGraw-Hill Book Company, 1964. Price: $10.50.

12. Stone and Gulvin. Machines for Power Farming. New York: John Wiley and Sons, Inc., 1957.

13. Transmission Theory. Racine, Wisconsin: J. I. Case Company.

14. Agricultural machinery manufacturer's service manuals.

THE CENTER FOR RESEARCH AND LEADERSHIP DEVELOPMENT
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THE OHIO STATE UNIVERSITY
980 KINNEAR ROAD
COLUMBUS, OHIO, 43212

INSTRUCTOR NOTE: As soon as you have completed teaching each module, please record your reaction on this form and return to the above address.

1. Instructor's Name_____

2. Name of school_____State_____

3. Course outline used: _____Agriculture Supply--Sales and Service Occupations
   _____Ornamental Horticulture--Service Occupations
   _____Agricultural Machinery--Service Occupations

4. Name of module evaluated in this report_____

5. To what group (age and/or class description) was this material presented?____
   _____

6. How many students:
   a) Were enrolled in class (total) _____
   b) Participated in studying this module _____
   c) Participated in a related occupational work experience program while you taught this module _____

7. Actual time spent teaching module:

		Recommended time if you were to teach the module again:
_____hours	Classroom Instruction	_____hours
_____hours	Laboratory Experience	_____hours
_____hours	Occupational Experience (Average time for each student participating)	_____hours
_____hours	Total time	_____hours

(RESPOND TO THE FOLLOWING STATEMENTS WITH A CHECK (√) ALONG THE LINE TO INDICATE YOUR BEST ESTIMATE.)

	VERY APPROPRIATE	NOT APPROPRIATE
8. The suggested time allotments given with this module were:		
9. The suggestions for introducing this module were:		
10. The suggested competencies to be developed were:		
11. For your particular class situation, the level of subject matter content was:		
12. The Suggested Teaching-Learning Activities were:		
13. The Suggested Instructional Materials and References were:		
14. The Suggested Occupational Experiences were:		

(OVER)

15. Was the subject matter content sufficiently detailed to enable you to develop the desired degree of competency in the student? Yes_____No_____
Comments:

16. Was the subject matter content directly related to the type of occupational experience the student received? Yes_____No_____
Comments:

17. List any subject matter items which should be added or deleted:

18. List any additional instructional materials and references which you used or think appropriate:

19. List any additional Teaching-Learning Activities which you feel were particularly successful:

20. List any additional Occupational Work Experiences you used or feel appropriate:

21. What do you see as the major strength of this module?

22. What do you see as the major weakness of this module?

23. Other comments concerning this module:

_____ _____
(Date) (Instructor's Signature)

_____
(School Address)